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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/624,537	07/23/2003	Katsuhiro Horikawa	M1071.1855/P1855	6662

32172 7590 07/01/2008
DICKSTEIN SHAPIRO LLP
1177 AVENUE OF THE AMERICAS (6TH AVENUE)
NEW YORK, NY 10036-2714

EXAMINER	
MAYES, MELVIN C	
ART UNIT	PAPER NUMBER
1791	
MAIL DATE	DELIVERY MODE
07/01/2008	PAPER

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte KATSUHIRO HORIKAWA and TOMOYUKI OGAWA
APPELLANTS

Appeal 2008-3112
Application 10/624,537
Technology Center 1700

Decided: July 1, 2008

Before JAMESON LEE, SALLY GARDNER LANE, and JAMES T. MOORE *Administrative Patent Judges*.

LANE, *Administrative Patent Judge*.

DECISION ON APPEAL

I. STATEMENT OF THE CASE

The appeal is from a Final Rejection of claims 1, 4-9, 11-16, and 21-27, all of the pending claims. 35 U.S.C. § 134. We have jurisdiction under 35 U.S.C. § 6(b). We reverse.

The application was filed July 23, 2003. It was published on July 8, 2004, as Patent Application Publication 2004/0129919 ("Pub. 2004/0129919"). The real party in interest is said to be Murata Manufacturing Co., Ltd. (App. Br. 2).

The Examiner relied on the following references:

Name	Number	Date	Abbreviation
Horikawa	6,080,328	Jun. 27, 2000	Horikawa '328
Ogawa	6,280,650	Aug. 28, 2001	Ogawa
Takeshima	2001/0045792A1	Nov. 29, 2001	Takeshima
Horikawa	6,383,408	May 7, 2002	Horikawa '408
Feltz	2002/0098333A1	Jul. 25, 2002	Feltz
Ponomarev	2004/0012000A1	Jan. 22, 2004	Ponomarev
Hoshi	JP 02-122511	May 10, 1990	JP '511
Nanao	JP 13-181035	Jul. 3, 2001	JP '035

Appellants did not argue against the prior art status of any of these references.

Appellants appealed the following rejections:

(A) claims 1, 4, 5, 7-9, 11, and 14-16 under 35 U.S.C. § 103(a) over Horikawa '328, Ponomarev, Horikawa '408 and JP '511;

(B) claims 6 and 21 under 35 U.S.C. § 103(a) over Horikawa '328, Ponomarev, Horikawa '408, JP '511, and Feltz;

(C) claims 12 and 13 under 35 U.S.C. § 103(a) over Horikawa '328, Ponomarev, Horikawa '408, JP '511, and JP '035;

(D) claims 22-26 under 35 U.S.C. § 103(a) over Horikawa '328, Ponomarev, Horikawa '408, JP '511, Ogawa, and Takeshima; and

(E) claim 27 under 35 U.S.C. § 103(a) over Horikawa '328, Ponomarev, Horikawa '408, JP '511, either Ogawa or Takeshima, and JP '035.

Appellants did not argue separately for the patentability of any of the rejected claims. Therefore, we review only a representative claim for each group of rejected claims. *See* Bd. R. 41.37(c)(1)(vii).

II. FINDINGS OF FACT

The record supports the following findings of fact as well as any other findings of fact set forth in this opinion, by at least a preponderance of the evidence.

1. Claim 1 recites:

> A method for manufacturing a monolithic piezoelectric ceramic actuator part which has a plurality of piezoelectric ceramic layers and spaced internal electrode layers disposed in said piezoelectric ceramic actuator, wherein said piezoelectric ceramic making up said piezoelectric ceramic layers is formed of a perovskite compound oxide expressed by the general formula of $AB0_3$, and comprises at least Pb for the A site component and comprises Ti or Ti and Zr for the B site component and said internal electrode layers contain Ag as a primary component; said method comprising:
>
> providing a piezoelectric ceramic powdered raw material wherein the molar quantity of said A site component is reduced by about 0.5 mol% to 5.0 mol% from that of a stoichiometric composition and the average valence of said B site component of the ceramic raw material is greater than that of the stoichiometric composition and is greater than 4.000 and less than 4.100;
>
> fabricating a layered article with said piezoelectric ceramic powdered raw material; and
>
> sintering said layered article within an atmosphere wherein the oxygen concentration is about 5% by volume or less but more than 0% by volume.

2. Horikawa '328 relates to "a method for producing a piezoelectric ceramic element . . . ." (Horikawa '328 abstract).

3. Horikawa '328 discloses a "sintered product comprising a primary component represented by the formula $Pb_a[Cr_xNb_{(1-x)})_yZr_{(1-b-y)}Ti_b]O_3$ wherein $0.95 \leq a \leq 1.05$ . . . ." (Horikawa col. 2, ll. 60-64).

4. The product $Pb_a[Cr_xNb_{(1-x)})_yZr_{(1-b-y)}Ti_b]O_3$ disclosed in Horikawa '328 has the general formula ABO_3, with at least Pb for the A site component and Ti and Zr for the B site component. (*See* Claim 1).

5. Horikawa '328 teaches a method for manufacturing monolithic piezoelectric ceramic elements wherein,

> each of the resultant green sheets was coated with an internal electrode paste containing Ag and Pd in a ratio of 7:3 so as to form an internal electrode layer on the green sheet. A plurality of the resultant internal electrode-bearing layers were placed one on another such that the internal electrodes alternately extend to opposite side faces to thereby obtain a layered product.

(Horikawa '328 col. 8, ll. 26-32).

6. Horikawa '408 relates to "[a] piezoelectric ceramic. . . which has a very low loss and superior workability in micro-fabrication." (Horikawa '408 abstract).

7. Horikawa '408 teaches that the piezoelectric ceramic with significantly low loss has "the composition of the primary components is represented by the formula $Pb_x\{(Mn_aNb_b)_yTi_zZr_{(1-y-z)}\}O_3$, the x, y, z, a, and b are, on a molar basis, such that $0.95 \leq x \leq 0.995$ . . . ." (Horikawa '408 col. 2, ll. 43-54).

8. The primary components of the ceramic taught in Horikawa '408 have "the general formula ABO_3 and comprises at least Pb for the A site component and comprises . . . Ti and Zr for the B site component . . . ." (Claim 1).

9. Horikawa '408 teaches that "when the amount of Pb is decreased below the stoichiometric content thereof, no foreign phase, such as a pyrochlore phase ($Pb_2Nb_2O_7$), exists in the sintered material, and hence,

a piezoelectric ceramic having an even lower loss can be obtained." (Horikawa '408 col. 3, ll. 14-18).

10. Ponomarev relates to piezoelectric ceramic compositions comprising the general formula

$$[(Pb_{1\text{-}m\text{-}n\text{-}p}Sr_mBa_nCd_p)(Zr_xTi_{1\text{-}x})_{1\text{-}k}(Bi_aMn_b)_k]O_3 + yBi_2O_3 + z(\text{Flourine Compound})$$

(Ponomarev abstract).

11. The piezoelectric ceramic compositions taught in Ponomarev include the general formula ABO_3, wherein A is at least Pb and B is Ti and Zr.

12. Ponomarev teaches that "[i]n order to achieve a high efficiency under dynamic operations such as in piezoelectric ceramic transformer, low-loss hard piezoelectric ceramic materials are required with a high piezo modulus dij, high electromechanical coupling coefficient, k_p, and a high dielectric constants." (Ponomarev ¶ [0002]).

13. JP '511 relates to "a laminate ceramic condenser wherein Ag or Ag-Pd conductors are made the internal electrodes and to a manufacturing method thereof." (JP '511, translation p. 2).

14. JP '511 teaches that to increase the amount of Ag, the less expensive component, an alloy can be used that has a reduced melting point and solidus temperature, but then "the conductive material diffuses into the inductive ceramic, reducing the insulating property of the inductive ceramic and decreasing the reliability of the condenser." (JP '511 translation at 4).

15. To address the problem of conductive material diffusion in the inductive ceramic, JP '511 teaches

> an electroconductive paste containing Ag or an Ag alloy is applied to unbaked inductive ceramic sheets and these ceramic sheets are layered and baked to form a laminate ceramic condenser for which internal electrodes formed by means of conductors that oppose [one another][1] with an inductive ceramic layer intervening, a laminate ceramic condenser manufacturing method characterized in that the baking atmosphere is a reduced to oxygen atmosphere.
>
> * * *
>
> Moreover, in practice the aforementioned reduced oxygen atmosphere is an atmosphere with an oxygen density of 50,000 ppm or less.

(JP '511, translation p. 6).

16. The ceramic powder used in JP '511 "consists respectively of 97% TiO_2, 2% CuO, and 1% ZrO_2 by weight . . . " (JP '511 p. 7), or "95% TiO_2, 4% CuO, and 1% ZrO_2 . . . ." (*Id.* p. 8-9).

17. Feltz relates to "piezolelectric devices whose electrode layers contain copper." (Fletz abstract).

18. Feltz teaches the "partial substitution of the quadravalent cations Zr and Ti on the B-positions of the ferroelectrical Perovskite ceramic," including with Ni and Nb. (Feltz at ¶ [0020]).

19. We do not find, and the Examiner has not directed us to, a teaching in Feltz of sintering with an oxygen concentration of about 5% by volume or less but more than 0% by volume.

20. JP '035 relates to "piezoelectric ceramic compositions used in piezoelectric vibrators . . . especially . . . piezoelectric ceramic compositions containing $Pb(Zn_{1/3}Nb_{2/3})O_3$-$PbTiO_3$-$PbZrO_3$, as main component." (JP '035 translation p. 2).

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[1] Brackets present in translation.

21. JP '035 teaches a "palladium content below 20%" and a sintering temperature "below 1000° C." (JP '035 ¶ [0003]).

22. We do not find, and the Examiner has not directed us to, a teaching in JP '035 of sintering with an oxygen concentration of about 5% by volume or less but more than 0% by volume.

23. Ogawa relates to a "piezoelectric buzzer formed by using a piezoelectric ceramic having both a higher heat resistance and a higher piezoelectric characteristics [sic] than those of a conventional product." (Ogawa abstract).

24. We do not find, and the Examiner has not directed us to, a teaching in Ogawa of sintering with an oxygen concentration of about 5% by volume or less but more than 0% by volume.

25. Takeshima relates to a "piezoelectric type electric acoustic converter. . . ." (Takeshima abstract).

26. We do not find, and the Examiner has not directed us to, a teaching in Takeshima of sintering with an oxygen concentration of about 5% by volume or less but more than 0% by volume.

III. ISSUES

The issues are whether Appellants have shown that the Examiner erred in rejecting

(A) claims 1, 4, 5, 7-9, 11, and 14-16 under 35 U.S.C. § 103(a) over Horikawa '328, Ponomarev, Horikawa '408 and JP '511;

(B) claims 6 and 21 under 35 U.S.C. § 103(a) over Horikawa '328, Ponomarev, Horikawa '408, JP '511, and Feltz;

(C) claims 12 and 13 under 35 U.S.C. § 103(a) over Horikawa '328, Ponomarev, Horikawa '408, JP '511, and JP '035;

(D) claims 22-26 under 35 U.S.C. § 103(a) over Horikawa '328, Ponomarev, Horikawa '408, JP '511, Ogawa, and Takeshima; and

(E) claim 27 under 35 U.S.C. § 103(a) over Horikawa '328, Ponomarev, Horikawa '408, JP '511, either Ogawa or Takeshima, and JP '035.

IV. LEGAL PRINCIPLES

To determine whether subject matter would have been obvious, "the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved . . . . Such secondary considerations as commercial success, long felt but unsolved needs, failure of others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented." *Graham v. John Deere Co. of Kansas City*, 383 U.S. 1, 17-18 (1966).

The Supreme Court has noted that a combination of references renders claimed subject matter obvious "if a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill." *KSR Int'l Co. v. Teleflex Inc.,* 127 S.Ct. 1727, 1740 (2007). The Court also recognized that

> [o]ften it will be necessary for a court to look to interrelated teachings of multiple patents; the effects of demands known to the design community or present in the marketplace; and the background knowledge possessed by a person having ordinary skill in the art, all in order to determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue. To facilitate review, this

> analysis should be made explicit. See *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006) ("[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness").

Id. at 1740-41.

V. ANALYSIS

(A) Claims 1, 4, 5, 7-9, 11, and 14-16

Claim 1 recites:

> A method for manufacturing a monolithic piezoelectric ceramic actuator part which has a plurality of piezoelectric ceramic layers and spaced internal electrode layers disposed in said piezoelectric ceramic actuator, wherein said piezoelectric ceramic making up said piezoelectric ceramic layers is formed of a perovskite compound oxide expressed by the general formula of AB03, and comprises at least Pb for the A site component and comprises Ti or Ti and Zr for the B site component and said internal electrode layers contain Ag as a primary component; said method comprising:
>
> providing a piezoelectric ceramic powdered raw material wherein the molar quantity of said A site component is reduced by about 0.5 mol% to 5.0 mol% from that of a stoichiometric composition and the average valence of said B site component of the ceramic raw material is greater than that of the stoichiometric composition and is greater than 4.000 and less than 4.100;
>
> fabricating a layered article with said piezoelectric ceramic powdered raw material; and
>
> sintering said layered article within an atmosphere wherein the oxygen concentration is about 5% by volume or less but more than 0% by volume.

(FF[2] 1). Horikawa '328 relates to a method for producing a piezoelectric ceramic element (FF 2) which comprises a "sintered product comprising a

[2] Finding of Fact.

primary component represented by the formula $Pb_a[Cr_xNb_{(1-x)})_yZr_{(1-b-y)}Ti_b]O_3$ wherein $0.95 \leq a \leq 1.05$ . . . ." (FF 3). This sintered product fits the general formula of ABO_3, with at least Pb for the A site component and Ti and Zr for the B site component, as claimed. (FF 4). Horikawa also teaches that

> each of the resultant green sheets was coated with an internal electrode paste containing Ag and Pd in a ratio of 7:3 so as to form an internal electrode layer on the green sheet. A plurality of the resultant internal electrode-bearing layers were placed one on another such that the internal electrodes alternately extend to opposite side faces to thereby obtain a layered product.

(FF 5). Thus, Horikawa '328 teaches that the "internal electrode layers contain Ag as a primary component," and that the resulting article is "a layered article with said piezoelectric ceramic powdered raw material . . . ."

Horikawa '408 teaches "a piezoelectric ceramic . . . which has a very low loss and superior workability . . . ." (FF 6). These characteristics are achieved in Horikawa '408 with primary components "represented by the formula $Pb_x\{(Mn_aNb_b)_yTi_zZr_{(1-y-z)}\}O_3$, the x, y, z, a, and b are, on a molar basis, such that $0.95 \leq x \leq 0.995$ . . ." (FF 7). The general formula for this component is ABO_3, with at least Pb for the A site component, and Ti and Zr for the B site component. (FF 8). Horikawa '408 explains that "when the amount of Pb is decreased below the stoichiometric content thereof, no foreign phase, such as a pyrochlore phase ($Pb_2Nb_2O_7$), exists in the sintered material, and hence, a piezoelectric ceramic having an even lower loss can be obtained." (FF 9). "Lower loss" piezoelectric ceramic materials of the general formula ABO_3 are desirable because they result in high efficiency, as explained by Ponomarev. (FFs 10-12).

The combination of Horikawa '328, Horikawa '408, and Ponomarev fails to teach sintering "within an atmosphere wherein the oxygen concentration is about 5% by volume or less but more than 0% by volume," as claimed.

JP '511 relates to "a laminate ceramic condenser wherein Ag or Ag-Pd conductors are made the internal electrodes . . . ." (FF 13). JP '511 notes that to increase the amount of Ag, the less expensive component, an alloy can be used that has a reduced melting point and solidus temperature, but then "the conductive material diffuses into the inductive ceramic, reducing the insulating property of the inductive ceramic and decreasing the reliability of the condenser." (FF 14). To address the problem of conductive material diffusion, JP '511 teaches

> an electroconductive paste containing Ag or an Ag alloy is applied to unbaked inductive ceramic sheets and these ceramic sheets are layered and baked to form a laminate ceramic condenser for which internal electrodes formed by means of conductors that oppose [one another][3] with an inductive ceramic layer intervening, a laminate ceramic condenser manufacturing method characterized in that the baking atmosphere is a reduced to oxygen atmosphere.

(FF 15). The "reduced oxygen atmosphere" taught in JP '511 is "an atmosphere with an oxygen density of 50,000 ppm or less." (FF 15).

The Examiner asserted that

> [i]t would have been obvious to one of ordinary skill in the art to have further modified the method of Horikawa '328 by firing (sintering) the laminate in a low oxygen atmosphere of less than 50,000 ppm oxygen, as taught by JP '511, as used to sinter a laminate of green sheets and Ag-Pd electrodes to improve reliability and reduce costs while retaining needed

[3] Brackets present in translation.

> characteristics. Sintering in an oxygen atmosphere of oxygen concentration in the range of up to 5 vol%, as claimed, would have been obvious to one of ordinary skill in the art as encompassed by the range of less than 50,000 ppm oxygen taught by JP '511.

(Ans. 5). Although the Examiner asserted that the reason to combine the references was to "improve reliability and reduce costs while retaining needed characteristics," he did not elaborate on what these characteristics were. Nor did the Examiner explain why those in the art would have had an expectation of success in "retaining needed characteristics" when the teachings of the prior art were combined.

Appellants argued that JP '511 relates to different ceramic materials than taught in Horikawa '328 and Horikawa '408. Specifically, JP '511 teaches "dielectric ceramics, not piezoelectric ceramics. They do not contain lead nor are they perovskites nor are they PZT type ceramics nor are they piezoelectric ceramics. . . . The crystal structure of a titanium dioxide type dielectric (as in JP '511) is very difference [sic] from that of a perovskite piezoelectric . . . ." (App. Br. 10). Indeed, the ceramic powder used in JP '511 "consists respectively of 97% TiO_2, 2% CuO, and 1% ZrO_2 by weight," or "95% TiO_2, 4% CuO, and 1% ZrO_2 . . ." (FF 16), which do not include Pb, a perovskite, or the general formula ABO_3 as defined in claim 1. Thus, the ceramic powder taught by JP '511 is not the same as that taught by Horikawa '328, Horikawa '408, or Ponomarev.

According to the Examiner:

> Appellants arguments that JP '511 concerns a ceramic capacitor made by sintering in a low oxygen atmosphere, which are dielectric ceramics and not piezoelectric ceramics and that the crystal structure of a dielectric as in JP '511 is very different

> from that of a perovskite piezoelectric as in the other references are not convincing. Although JP '511 does discuss the benefit of sintering Ag/Pd paste in the atmosphere in terms of making a laminate ceramic capacitor, the Examiner's position is that the teaching [is] also pertinent to co-firing a piezoelectric ceramic with Ag/Pd paste. Suppressing diffusion of Ag into the ceramic during firing as taught by JP '511 is just as relevant to making a laminate with piezoelectric ceramic material as with a dielectric ceramic material.

(Ans. 12-13).

Neither the Examiner nor Appellants has provided us with an abundance of information about the implications of different ceramic compositions. Appellants have not explained why those of skill in the art would have thought that different crystal structures would mean a different reaction to a reduced oxygen atmosphere. Similarly, the Examiner has not explained why even if the problem of suppressing diffusion of Ag in the ceramic is "pertinent" or "relevant" to both types of ceramic, those of skill in the art would have recognized that it could be solved in the same way, with a reduced oxygen atmosphere for both types of ceramic.

In light of this lack of information and because it is the Examiner's burden to provide a reason to combine references and a reasonable expectation of success in the combination, we determine that the Examiner erred in rejecting claims 1, 4, 5, 7-9, 11, and 14-16 under 35 U.S.C. § 103(a) over Horikawa '328, Horikawa '408, Ponomarev, and JP '511.

(B) Claims 6 and 21

The rejection of claims 6 and 21 was based on the combination of Horikawa '328, Horikawa '408, Ponomarev, JP '511, and Feltz. Claims 6 and 21 depend on claim 1, directly or indirectly. For the reasons explained above, we are not convinced that there would have been a reasonable

expectation of success in the combination of Horikawa '328, Horikawa '408, Ponomarev, and JP '511 to render "sintering said layered article within an atmosphere wherein the oxygen concentration is about 5% by volume or less but more than 0% by volume" obvious. Because Feltz does not teach this element (FF 19), the Examiner erred in rejecting claims 6 and 21.

(C) Claims 12 and 13

The rejection of claims 12 and 13 was based on the combination of Horikawa '328, Horikawa '408, Ponomarev, JP '511, and JP '035. Claims 12 and 13 ultimately depend on claim 1. For the reasons explained above, we are not convinced that there would have been a reasonable expectation of success in the combination of Horikawa '328, Horikawa '408, Ponomarev, and JP '511 to render "sintering said layered article within an atmosphere wherein the oxygen concentration is about 5% by volume or less but more than 0% by volume" obvious. Because JP '035 does not teach this element (FF 22), the Examiner erred in rejecting claims 12 and 13.

(D) Claims 22-26

The rejection of claims 22-26 was based on the combination of Horikawa '328, Horikawa '408, Ponomarev, JP '511, Ogawa, and Takeshima. (Ans. 7). Claim 22, the representative claim, requires "sintering said layered article within an atmosphere wherein the oxygen concentration is about 5% by volume or less but more than 0% by volume." (App. Br., Claims Appendix) As explained above, we are not convinced that there would have been a reasonable expectation of success in the combination of Horikawa '328, Horikawa '408, Ponomarev, and JP '511 to render this claim element obvious. Because neither Ogawa nor Takeshima teach this element (FFs 24 and 26), the Examiner erred in rejecting claims 22-26.

(E) Claim 27

The rejection of claim 27 was based on the combination of Horikawa '328, Horikawa '408, Ponomarev, JP '511, Ogawa, Takeshima, and JP '035. Claim 27 depends on claim 22. For the reasons explained above, we are not convinced that there would have been a reasonable expectation of success in the combination of Horikawa '328, Horikawa '408, Ponomarev, and JP '511 to render "sintering said layered article within an atmosphere wherein the oxygen concentration is about 5% by volume or less but more than 0% by volume" obvious. Because JP '035 does not teach this element (FF 22), the Examiner erred in rejecting claim 27.

VI. ORDER

Upon consideration of the record and for the reasons given,

the Examiner's rejection of claims 1, 4, 5, 7-9, 11, and 14-16 under 35 U.S.C. § 103(a) over Horikawa '328, Ponomarev, Horikawa '408 and JP '511 is REVERSED;

the Examiner's rejection of claims 6 and 21 under 35 U.S.C. § 103(a) over Horikawa '328, Ponomarev, Horikawa '408, JP '511, and Feltz is REVERSED;

the Examiner's rejection of claims 12 and 13 under 35 U.S.C. § 103(a) over Horikawa '328, Ponomarev, Horikawa '408, JP '511, and JP '035 is REVERSED;

the Examiner's rejection of claims 22-26 under 35 U.S.C. § 103(a) over Horikawa '328, Ponomarev, Horikawa '408, JP '511, Ogawa, and Takeshima is REVERSED; and

the Examiner's rejection of claim 27 under 35 U.S.C. § 103(a) over Horikawa '328, Ponomarev, Horikawa '408, JP '511, either Ogawa or Takeshima, and JP '035 is REVERSED.

REVERSED

rvb

Edward A. Meilman
DICKSTEIN SHAPIRO MORIN & OSHINSKY LLP
41st Floor
1177 Avenue of the Americas
New York, NY 10036-2714